

# SPECIFIC GRAVITY OF COARSE AGGREGATE

## AASHTO T 85

### GLOSSARY

**Absorption:** The increase in weight due to water contained in the pores of the material.

**Bulk Specific Gravity (also known as Bulk Dry Specific Gravity):** The ratio of the weight in air of a unit volume of aggregate at a stated temperature to the weight in air of an equal volume of gas-free distilled water at the stated temperature.

**Bulk SSD Specific Gravity:** The ratio of the weight in air of a unit volume of aggregate, including the weight of water within the voids filled to the extent achieved by submerging in water for approximately 15 hours, to the weight in air of an equal volume of gas-free distilled water at the stated temperature.

**Apparent Specific Gravity:** The ratio of the weight in air of a unit volume of the impermeable portion of aggregate (does not include the permeable pores in aggregate) to the weight in air of an equal volume of gas-free distilled water at the stated temperature.

**SSD - Saturated, Surface Dry.** The condition in which the aggregate has been soaked in water and has absorbed water into its pore spaces. The excess, free surface moisture has been removed so that the particles are still saturated, but the surface of the particle is essentially dry.

### SCOPE

Specific Gravity is the ratio of the weight of a given volume of aggregate to the weight of an equal volume of water. Water, at a temperature of 73.4°F (23°C) has a specific gravity of 1. Specific Gravity is important for several reasons. Some deleterious particles are lighter than the good aggregates. Tracking specific gravity can sometimes indicate a change of material or possible contamination. Differences in specific gravity may be used during production to separate the deleterious particles from the good using a heavy media liquid.

Specific gravity is critical information for the Hot Mix Asphalt Design Engineer. The value is used in calculating air voids, voids in mineral aggregate (VMA), and voids filled by asphalt (VFA). All are critical to a well performing and durable asphalt mix. Water absorption can also be an indicator of asphalt absorption. A highly absorptive aggregate may lead to a low durability asphalt mix.

In Portland Cement Concrete the specific gravity of the aggregate is used in calculating the percentage of voids and the solid volume of aggregates in computations of yield. The absorption is important in determining the net water-cement ratio in the concrete mix. Knowing the specific gravity of aggregates is also critical to the construction of water filtration systems, slope stabilization projects, railway bedding and many other applications.

This test method determines the specific gravity of coarse aggregates that have been soaked for a period of 15 hours (Figure 1). There are four determinations that may be made from this procedure. They are as follows:



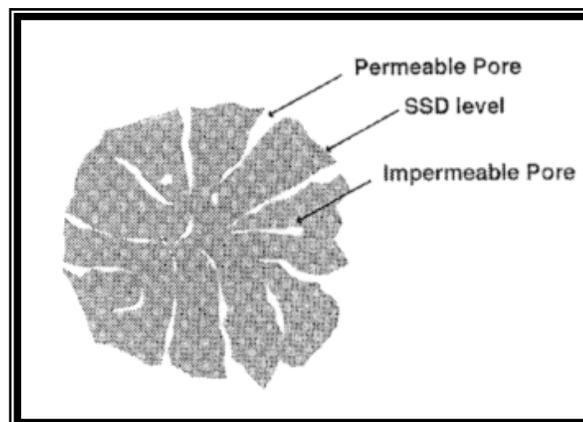
**Figure 1**  
Coarse Aggregate Gravity Apparatus

A. Bulk Specific Gravity (Gsb) (also known as Bulk Dry Specific Gravity)

The ratio of the weight in air of a unit volume of aggregate at a stated temperature to the weight in air of an equal volume of gas-free distilled water at a stated temperature (Figure 2). This unit volume of aggregates is composed of the solid particle, permeable voids, and impermeable voids.

$$Gsb = A / (B-C)$$

Where:      A = Oven dry weight.  
               B = SSD weight.  
               C = Weight in water.



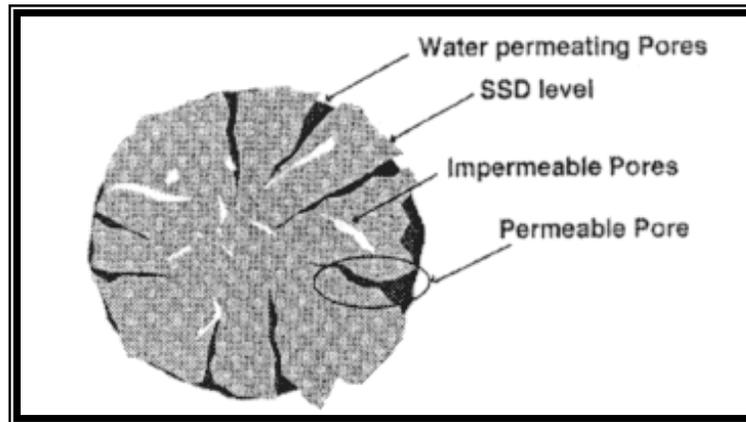
**Figure 2**  
Diagram of Bulk Specific Gravity

B. Bulk SSD Specific Gravity (Gsb SSD)

The ratio of the weight in air of a unit volume of aggregate, INCLUDING the weight of water within the voids filled to the extent achieved by submerging in water for approximately 15 hours, to the weight in air of an equal volume of gas-free distilled water at a stated temperature (Figure 3).

$$G_{sb\ SSD} = B / (B - C)$$

Where:        B = SSD weight.  
                  C = Weight in water.



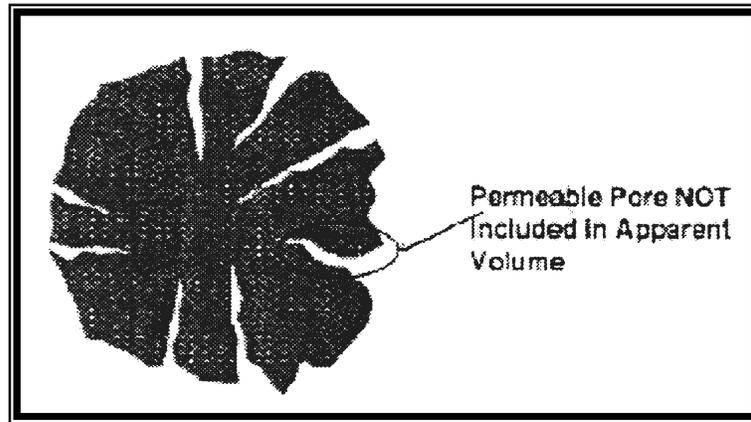
**Figure 3**  
Diagram of Bulk SSD Specific Gravity

C. Apparent Specific Gravity (Gsa)

This ratio of the weight in air of a unit volume of the IMPERMEABLE portion of aggregate (does not include the permeable pores in aggregate) to the weight in air of an equal volume of gas-free distilled water at a stated temperature (Figure 4).

$$G_{sa} = A / (A - C)$$

Where:        A = Oven dry weight.  
                  C = Weight in water



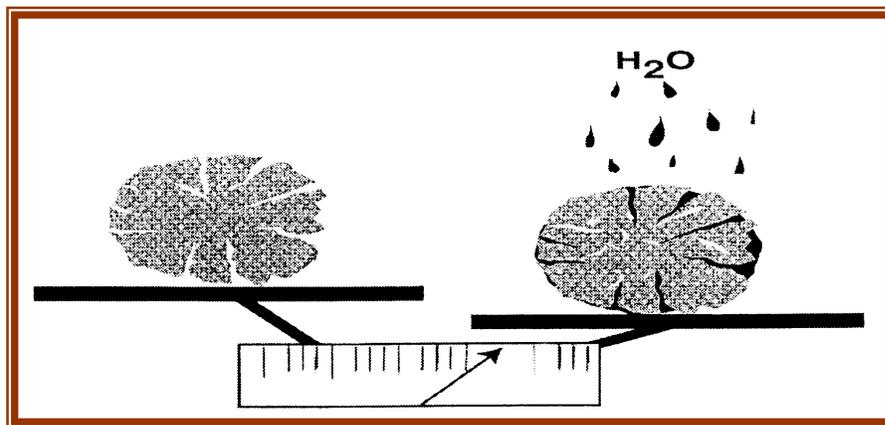
**Figure 4**  
Diagram of Apparent Specific Gravity

D. Absorption (% Abs.)

The increase in weight of aggregate due to water in the pores of the material, but not including water adhering to the outside surface of the particles (Figure 5).

$$\% \text{ Abs.} = [ (B - A) / A ] \times 10$$

Where:      A = Oven dry weight.  
              B = SSD weight.



**Figure 5**  
Increase in Mass due to Absorption of Water

**SUMMARY OF TEST**

**Apparatus**

Balance, conforming with class G5 (AASHTO M231)

Sample container, wire basket of No. 6 (3.35 mm) or less mesh wire cloth, with a capacity of 1 to 1 3/4 gal. (4 to 7 L) to contain aggregate with a nominal maximum size of 1 1/2 in. (37.5 mm) or smaller; larger basket for larger aggregates.

Water tank, watertight and large enough to completely immerse aggregate and basket, equipped with an overflow valve to keep water at a constant level.

Suspended Apparatus, wire used to suspend apparatus with the smallest practical diameter. A hi-test fishing leader or other thin wire with utility hook can be used with a small hook attached to the handle of the basket or sample container.

Sieves, No. 4 (4.75 mm) or other size as needed, conforming to AASHTO M 92.

**Procedure**

1. Thoroughly mix the sample and reduce the sample to the required size (Figure 6) in accordance with AASHTO T248 (Reducing Field Samples of Aggregate to Test Size). Use sample sizes as indicated in Table 1.



**Figure 6**  
Reducing Sample to Test Size

TABLE 1

Nominal Maximum Size	Minimum Sample Weight
1/2 in. (12.5 mm)	4.4 lbm (2 kg)
3/4 in. (19 mm)	6.6 lbm (3 kg)
1 in. (25 mm)	8.8 lbm (4 kg)
1 1/2 in. (37.5 mm)	11 lbm (5 kg)
2 in. (50 mm)	18 lbm (8 kg)
2 1/2 in. (63 mm)	26 lbm (12 kg)
3 in. (75 mm)	40 lbm (18 kg)

2. Dry sieve the sample through a No. 4 (4.75 mm) sieve and discard any material that passes the sieve (if a substantial amount of material passes the No. 4 (4.75 mm) sieve, you may need to use a No. 8 (1.18 mm) sieve instead of the No. 4 (4.75 mm), or you may need to perform a specific gravity on the minus No. 4 (4.75 mm) material). Wash the aggregate retained on the No. 4 (4.75 mm) sieve.
3. Dry test sample to constant weight in an oven regulated at  $230 \pm 9^{\circ}\text{F}$  ( $110 \pm 5^{\circ}\text{C}$ ). Cool sample at room temperature for 1 to 3 hr. After the cooling period, immerse the aggregate in water at room temperature for a period of 15 hr.
4. Place entire sample in a container and weigh in water maintained at  $73.4 \pm 3^{\circ}\text{F}$  ( $23 \pm 1.7^{\circ}\text{C}$ ). Shake container to release any entrapped air and weigh on minimum diameter wire suspended below scale apparatus. Ensure that the water overflow outlet is working properly to compensate for the water displaced by the sample (Figure 7). Record to the nearest 1.0 g or 0.1% of total weight, whichever is greater, as the weight in Water (C).



**Figure 7**  
Water Overflow Outlet

5. Remove the sample from the container and drain any excess water from the aggregate. Using an absorbent cloth (an absorbent towel usually works best), roll the aggregate until the surface water has been removed (Figure 8). Rolling up the aggregate into the towel and then shaking and rolling the aggregate from side to side is also an effective procedure in reducing the sample to an SSD (saturated, surface-dry) condition.



**Figure 8**  
Removing Excess Water

An SSD condition is one in which the aggregate has no FREE water on the surface of the aggregate. If the test sample dries past the SSD condition, immerse the sample in water for 30 minutes and resume the process of surface-drying.

6. Weigh SSD sample to nearest 1.0 g or 0.1% of the total weight, whichever is greater and record this as SSD weight.
7. Dry the sample in a pan to a constant weight in an oven set at  $230 \pm 9^{\circ}\text{F}$  ( $110 \pm 5^{\circ}\text{C}$ ). Cool in air at room temperature for 1 to 3 hr, or until the aggregate can be comfortably handled. Record weight to nearest 1.0 g or 0.1%, whichever is greater, as oven dry weight.

### Calculations

Determine calculations based on appropriate formula.

A = Oven dry weight

B = SSD weight.

C = Weight in water

Bulk Specific Gravity (Gsb)

$$Gsb = A / (B-C)$$

Bulk SSD Specific Gravity (Gsb SSD)

$$Gsb\ SSD = B / (B-C)$$

Apparent Specific Gravity (Gsa)

$$Gsa = A / (A-C)$$

Absorption (% Abs)

$$\% \text{ Abs.} = [(B-A) / A] \times 100$$

Example

<b>Trial</b>	<b>A</b>	<b>B</b>	<b>C</b>	<b>B-C</b>	<b>A-C</b>	<b>B-A</b>
<b>1</b>	<b>2030.9</b>	<b>2044.9</b>	<b>1304.3</b>	<b>740.6</b>	<b>726.6</b>	<b>14.0</b>
<b>2</b>	<b>1820.0</b>	<b>1832.5</b>	<b>1168.1</b>	<b>664.4</b>	<b>651.9</b>	<b>12.5</b>
<b>3</b>	<b>2035.2</b>	<b>2049.4</b>	<b>1303.9</b>	<b>745.5</b>	<b>731.3</b>	<b>14.2</b>

<b>Trial</b>	<b>Bulk SSD B/B-C</b>	<b>Bulk A/B-C</b>	<b>Apparent A/A-C</b>	<b>Abs. (B-A/A)100</b>
<b>1</b>	<b>2.761</b>	<b>2.742</b>	<b>2.795</b>	<b>0.691</b>
<b>2</b>	<b>2.758</b>	<b>2.739</b>	<b>2.792</b>	<b>0.698</b>
<b>3</b>	<b>2.749</b>	<b>2.730</b>	<b>2.783</b>	<b>0.698</b>
<b>Ave.</b>	<b>2.756</b>	<b>2.737</b>	<b>2.790</b>	<b>0.693</b>

A = Weight of Oven Dry Specimen in Air

B = Weight of SSD Specimen in Air

C = Weight of SSD Specimen in Water

These calculations demonstrate the relationship between G<sub>sb</sub>, G<sub>sb</sub> SSD, and G<sub>sa</sub>. The G<sub>sb</sub> (bulk specific gravity) will always be the lowest value since the volume calculated includes voids permeable to water. The G<sub>sb</sub> SSD (bulk specific gravity at SSD) will always be the intermediate value, and the G<sub>sa</sub> (apparent specific gravity) will always be the highest, since the volume calculated includes only the "solid" aggregate particle (does not include those voids permeable to water). When conducting this test, check to make sure the values calculated make sense in relation to one another.